# Mechanical Engineering Doctoral Defense

## A Heterogeneous Porous Media Model for Fluid Flow Simulation

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## abstract

Owing to the surge in development of endovascular devices such as coils and flow diverter stents, doctors are inclined to approach surgical cases non-invasively more often than before. Treating brain aneurysms as a bulging of a weakened area of a blood vessel is no exception. Therefore, promoting techniques that can help surgeons have a better idea of treatment outcomes are of invaluable importance. In order to investigate the effects of these devices on intra-aneurysmal hemodynamics, the conventional computational fluid dynamics (CFD) approach uses the explicit geometry of the device within an aneurysm and discretizes the fluid domain to solve the Navier-Stokes equations. However, since the devices are made of small struts, the number of mesh elements in the boundary layer region would be considerable. This cumbersome task led to the implementation of the porous medium assumption. In this approach, the explicit geometry of the device is eliminated, and relevant porous medium assumptions are applied. Unfortunately, as it will be shown in this research, some of the porous medium approaches used in the literature are over-simplified. For example, considering the porous domain to be homogeneous is one major drawback which leads to significant errors in capturing the intra-aneurysmal flow features. Specifically, since the devices have to comply with the complex geometry of an aneurysm, the homogeneity assumption is not valid. In this research, a novel heterogeneous porous medium approach is introduced. This results in a substantial reduction in the total number of mesh elements required to discretize the flow domain while not sacrificing the accuracy of the method by over-simplifying the utilized assumptions.

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